Human Factors Research

on

519 Recent US Air Carrier

Passenger Evacuation Events

by

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ABSTRACT

The Federal Aviation Administration (FAA) and National Transportation Safety Board (NTSB) require reporting of the use of emergency egress systems and passenger evacuations. Information on these events is used by safety experts to evaluate the design and operational characteristics of evacuation systems and air crew training. Unless the required reports are created and properly forwarded to the FAA and/or NTSB, useful information from past events is not available.

Recent studies indicate that the FAA or NTSB were not receiving or not properly recording data on air carrier emergency evacuations that were occurring every five or six days. This paper reviews research on 519 recent evacuations from a human factors viewpoint. Where available, it records their frequency, the reasons for undertaking them, and demographic information on the injuries that were reported as a result of the evacuation. Approximately 60% of the reported events were not contained in the computerized data of the FAA or NTSB.

EXECUTIVE SUMMARY

As mandated by the public, through Acts of the US congress, the Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB) both have air carrier safety oversight functions. By the use of the regulatory process, the FAA has developed airworthiness standards for the design and utilization of air carrier aircraft evacuation systems. Some FAA standards also apply to the training of flight and cabin crews in the proper use of passenger evacuation techniques. The NTSB, in filling its role of monitoring and promoting transportation safety, specifically in air travel, has developed various studies that address the evacuation of air carrier aircraft. By making use of the findings of these studies, NTSB recommendations have been made as to how the FAA might improve upon existing regulations and policies that address public safety when aircraft evacuations take place.

In the US, Part 121 Air Carrier evacuations associated with aviation accidents fortunately only occur three or four times per year. Because these accidents are rare, dissimilar, and random events, the NTSB, FAA, and other aviation safety experts have limited opportunity to study the emergency evacuation process “in real time”. Therefore, statistical information on passenger demographics, injuries, and other useful data has not been available for study. For the same reason, the FAA and NTSB had limited data on how to evaluate the effectiveness of their safety oversight function on the effectiveness of aircraft evacuation systems.

Evacuation simulations, as required during aircraft and air carrier certification, and in airline training programs, have provided some additional data on the dynamics of the evacuation process. In addition to the question of the validity of data from simulation vs. real time events, there is the potential risk of injuries to the persons who partake in simulated evacuation events. To address these two issues, Dr. Michael K.

Hynes (the author of this paper) has undertaken additional studies of the evacuation process. Studies by Hynes have shown that, in addition to accident or "crash" related emergency evacuations and simulated events, there are many *non-crash* (accident) related evacuation events taking place each year. Hynes identified over 500 evacuation events that have taken place in the US over a recent nine year period.

These evacuation events, called precautionary evacuations, were taking place at the rate of one each five or six days. Based upon the data acquired through this research, in some years about 6,000 persons were required to participate in a Part 121 air carrier precautionary evacuation event. For the purpose of Hynes' research, a precautionary evacuation event was when the aircraft's emergency egress system was deployed, or if not deployed, the aircraft's passengers and crew were required to conduct an unscheduled deplanement at other than a normal "gate" location.

FAA Civil Aero-medical Institute (CAMI) cabin safety experts quickly realized that precautionary evacuation events could be a source of new and useful information on the dynamics of the evacuation process under realistic and stressful situations. Since the FAA is constantly seeking new data (Ref. FAA Policy Statement No. ANM-98-2, Notice of policy statement and request for comments), the FAA became interested in Hynes' work. As a follow-up of Hynes' research, FAA/CAMI funded two new studies on emergency evacuations. The first contract No. 96-P-51602 (1996), "Emergency Egress System Use and Emergency Evacuation Events by Part 121 and 135 Air Carriers from 1988 to 1996," identified 519 evacuation events that took place at 136 airports. These airports represented approximately 90% of the reported passenger enplanements (1995 data) during the period studied. Based upon an analysis of the data, it was estimated that 47,520 people, almost six thousand per year, were required to evacuate from an air carrier aircraft as a precautionary measure that was not a result of a reportable accident (crash) or incident.

A second contract, No. 97-P-53815 (1997), "Demographic and Injury Data on Persons Injured during Part 121 Air Carrier Precautionary Emergency Evacuation Events," more carefully analyzed injury data associated with evacuations. These two studies also collected data as to the reasons for conducting precautionary evacuations, the types of injuries that passengers and crew members received during evacuations, and the potential annual costs of these events. Recommendations were then made as to how to decrease the frequency of precautionary evacuations and how to reduce the number of injuries when evacuations took place.

The paper being presented here also describes a unique research method that was used to acquire data. At the initiation of the research, it was discovered that the FAA and NTSB records on evacuation events did not match, and over 60% of the evacuation events were not recorded in the computerized safety data records of either agency. To acquire data, Hynes made direct contacts with other sources, including airport management. The airport respone rate for the 1996 research was 92.1%, and

for the 1997 research it was 100%. This was considered an extremely high response rate and an indication that, when properly approached, airport management will furnish useful safety data.

The estimated cost of precautionary evacuations was over 16 million dollars per year. When one considers that in some years almost 6,000 persons were forced to undertake an aircraft evacuation, the potential cost is much higher. In addition to these dollar costs, there is emotional pain, physical suffering, lost wages, and other social costs that make efforts on reducing the number of evacuation events a worthwhile goal. This supports the need for continued important safety research on emergency evacuations. It was estimated that 75% of the evacuations could have been avoided.

The two CAMI funded research programs discussed here have the potential for furnishing new and useful data for aviation safety experts who are interested in learning more about the dynamics of emergency evacuation events.

PURPOSE or OBJECTIVE OF THE RESEARCH

In harmony with the FAA's interest in continuing research efforts on the subject of air carrier emergency evacuation events[1] the FAA/CAMI has been willing to fund research on this important safety issue. It was believed that, by funding two research projects,[2] the FAA/CAMI could gain useful information on the dynamics of air carrier emergency evacuations.

The research objective was to acquire "timely" data, that is, data that was recorded immediately after the event took place. This data would then be used to analyze the frequency of evacuations and several human factor aspects of evacuations. It was intended that the research data would indicate the reasons for the evacuations, and furnish demographic information on the persons who participated in the evacuation. Therefore, information on the age, sex, height, weight, injuries of persons who participated in evacuations, and data on social and/or economic losses associated with evacuations was sought.

Additional goals of the research was to find new ways to acquire data on evacuation events, and to evaluate the quality of the FAA's and NTSB's computerized safety data base on emergency evacuations. Unless the required FAA and/or NTSB reports on emergency evacuations were created, properly forwarded to the FAA and NTSB, and then entered into the computerized safety data system of these agencies, no analysis of these events could be made.

THE PROBLEM

Only four or five air carrier accidents occur each year in the US. These accidents are considered rare, dissimilar, and random events. Even when emergency evacuations take place as a result of accidents, for the reasons stated previously, very little data can be acquired on the dynamics of the evacuation. The need for further information on the emergency evacuation process is required to address the present ongoing aircraft and airline certification process.

As a result of research by Hynes[3] it became apparent that emergency egress system use, or an emergency evacuation event, was taking place in the US about once every five or six days.

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[1] FAA Policy Statement No. ANM-98-2, "Notice of policy statement and request for comments," Federal Register, March 17, 1998.

[2] FAA Contract No. 96-P-51602, "Emergency Egress System Use and Emergency Evacuation Events by Part 121 and Part 135 Air Carriers from 1988 to 1996," and Contract No. 97-P-53815, "Demographic and Injury Data on Persons Injured During Part 121 Air Carrier Precautionary Emergency Evacuation Events".

[3] Hynes, M. 1994 (March). "Air Carrier Non-Crash Related Emergency Evacuation Events: Necessary or Negligent Aeronautical Decisions", 21st Annual Conference on Aviation Psychology, Western European Association for Aviation Psychology, Trinity College, Dublin, Ireland; (July) "Air Carrier Non-Crash Related Emergency Evacuation Events: Missed Learning Opportunities", 12th International System Safety Conference." System Safety Society, New Orleans, Vol. II, pp 204-217.

While Hynes identified 519 emergency evacuation events in a nine year period, the FAA's computerized safety data base had record of only about 43.2% of them. The NTSB's computerized data base had records of less than 10% of the evacuations. While air carrier accidents that also resulted in emergency evacuations were recorded by the FAA and NTSB, hundreds of other evacuations, called *precautionary evacuations,* were not being brought to the attention of either agency.

Learning why information on most of the *precautionary evacuation* events were not contained in the records of the FAA and/or the NTSB was not a task of either research contract. This is an area that should be addressed by future work activities.

THE SOLUTION

When Hynes discovered that the FAA and NTSB computerized safety data system failed to contain many emergency evacuation events that Hynes knew took place, he sought other sources of information on these events.

Some of these sources were, (1) direct contacts with major airlines[4] (public relation departments, the airline's office of safety, and legal staff); (2) search of the literature (trade publications and printed media sources); (3) airline insurance firms; (4) airline insurance claim adjusting firms; (5) plaintiff attorneys who represented injured passengers; (6) litigation records from WESTLAW; (7) computerized reports from the National Aeronautics and Space Administration (NASA)[5], and (8) direct contacts with airport management or other airport staff.

THE RESULTS OF THE RESEARCH EFFORTS

(1) Direct Contacts With Major Airlines

As might be expected, the response from the major airlines varied greatly. Airline public relations departments were of no assistance. They refused to discuss any subject that they felt had negative public relations value. While most airline safety offices were interested in helping with the research, several were restrained from furnishing useful data by their upper management or the airline's legal department. The response from airline legal departments was helpful in two thirds of the cases. While all of the airlines' legal departments wanted copies of the results of the research, only 50% *gave full cooperation* to the research project. These airline attorneys supplied useful data on injuries claimed by passengers and how these claims were resolved. In some cases, on instructions from an airline's legal department, this cooperation was furnished by the airline's insurance carrier or the firm that processed passenger injury insurance claims for the airline. In one case, the same insurance adjusting firm processed claims for two of the airlines.

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[4] American Airlines, Continental Air Lines, Delta Air Lines, Northwest Airlines, Southwest Airlines, Trans World Airlines, United Airlines, and US Air.

[5] NASA's Aviation Safety Reporting System, Report No. 3223, 11/19/93, Report No. 4412, 04/01/96, and Report No. 4704, 12/12/96, Ames Research Center, Moffett Field, CA.

(2) Search of the Literature (trade publications and printed media sources)

Aviation trade publications carried information on major air carrier accidents but very seldom reported on the use of emergency egress systems or emergency evacuations undertaken as precautionary measures. General media sources, such as newspapers, were helpful but not a reliable source of detailed information when an evacuation event had taken place. The use of computers to search newspaper sources helped to scan a large number of prominent newspapers for data. Newspaper articles were used to suggest the need to find additional information on evacuation events at specific airports that were not reported elsewhere.

(3) Airline Insurance Firms

As discussed previously, in some cases, where directed by an airline, insurance firms provided data on claimed passenger injuries that had resulted from an evacuation of an air carrier's aircraft.

(4) Airline Insurance Claim Adjusting Firms

As discussed previously, in some cases, where directed by an airline, insurance claim adjusting firms provided data on claimed passenger injuries that had resulted from an evacuation of an air carrier's aircraft.

(5) Plaintiff's Attorneys Who Represented Injured Passengers

Unless a passenger's claimed injuries were associated with a major airline accident, the larger aviation law firms, that specialize in plaintiff work, did not usually represent any persons who were claiming injuries from emergency evacuations. In almost every case, legal actions against airlines for claimed passenger injuries were handled by the passenger's "local" attorney. Except in a few instances, the names of these attorneys were unknown. Therefore, plaintiff attorneys were not a significant source of useful information for this research.

(6) Litigation Data From WESTLAW

Approximately 61.2% of all passenger claims for injuries sustained during an evacuation were withdrawn or settled "out of court". Of the 38.8% of the claims that progressed to the litigation stage, only 9% continued to trial. Less than 1% of all passenger injury claims actually were litigated before some court jurisdiction. Therefore, useful "public" court records on claims for passenger injuries for evacuations were almost non-existent. With 99% of the claims being settled "out of court" or withdrawn by the plaintiff passenger, the search of computerized litigation data bases, such as WESTLAW were not productive.

(7) Computerized Reports From NASA

Since 1975, NASA has been tasked with collecting and maintaining a confidential safety reporting system data base. This program, known as the Aviation Safety Reporting System

(ASRS), is administrated by the Ames Research Center at Moffett Field, CA. The government contractor for this program during the research was the Battle Memorial Institute. The NASA ASRS data base now contains aviation safety related information on over 300,000 full-form reports. These reports are usually submitted by members of the aviation community that have first hand knowledge of the incidents being reported upon. The reports are timely (they are normally filed within ten days to meet the requirements of FAA regulation Part 91.25), and are frequently matched by reports from several sources on the same event.

Three NASA ASRS reports were used as information sources for this research. The reports were No. 3223, 11/19/93, No. 4412, 04/01/96, and No. 4704, 12/12/96. These three ARSA furnished reports contained 172 submittals on air carrier evacuation events. However, many of the submittals overlapped in time and in some cases, more than one report was for the same event. While confidential in nature, with identifying data removed, the ARSA reports were useful for cross checking on the number of evacuation events at specific airports.

(8) Direct Contacts With Airport Management

After analyzing data on emergency evacuations from the seven sources listed previously, it was apparent that a large number of evacuation events were not contained in any of these sources. To address this shortfall of data, since Hynes knew that every airport at which an emergency evacuation had taken place would have some type of record of the event, airport staff became a major source of data. Also, if airport or local crash-fire-rescue (CFR) staff responded to the incident, they would have complete records of the type of information that was needed by the FAA, NTSB, and other safety experts who were interested in analyzing data on evacuations.

Between April 15, 1993 and May 13, 1994, a survey instrument was sent to 71 airports. In late 1995, a second survey was sent to the 40 most active US airports. A third survey, of 59 airports, was conducted in late 1996. These 59 airports included the 50 most active US airports, plus nine additional airports that were known to have had emergency evacuation events. The total number of different airports contacted was 136. These airports accounted for approximately 90% of passenger enplanements (1995 data) and an estimated 90% of all emergency evacuation events. The results of these surveys were contained in the report submitted under the FAA/CAMI Contract No. 96-P-51602.

In late 1997 and early 1998, under FAA/CAMI Contract No. 97-P-53815, some of the previously contacted airports (24) were asked to submit specific passenger demographic data and injury information on the emergency evacuations that took place at their airports. These 24 airports accounted for 70% of the total emergency evacuation events reported in the 1996 study, and 47.3% of passenger enplanements (1995 data). The listings of the airports contacted for each survey or study were listed in Appendix A of the FAA/CAMI reports.

Each survey required at least three mailings. A sample of several research instruments, such as the letters sent to the airports, along with the format used for collecting information from the airports, and a copy of the telephone interview format used to acquire data on passenger injuries are contained in the reports to FAA/CAMI. The response rate from the airport's

management or other staff, for contract No. 96-P-51602, was 92.1%. The response rate for the 1997-1998 contract, No. 97-P-53815 was 100%. A sample of the collected data format from airports on emergency evacuation events is contained in Appendix C and a sample of the data on claimed injuries resulting from evacuation events is contained in Appendix D.

FINDINGS OF THE RESEARCH

During the nine year period covered by this research (1988 through 1996), while air carrier accidents were occurring only four or five times per year, approximately once each five or six days, the use of an emergency egress system, or an emergency evacuation of an air carrier aircraft was taking place somewhere in the US.

For the purpose of the research reported on herein, "an evacuation event" was an event in which passengers and crew members were forced to conduct an unscheduled deplanement at other than normal gate locations, and the emergency egress system was or *was not* deployed." These evacuations are usually called precautionary evacuations. It is important to note that *accident related evacuations were not included in this study*.

Findings from the FAA/CAMI Contract No. 96-P-51602

a. The period studied was from January 1, 1988 to December 31, 1996. Because of the unavailability of data from several sources, which was required to add to the validity of the information collected, a data cut-off date of November 1, 1996 was used. This resulted in a 106 month study period. The number 106 was used to calculate monthly and yearly averages.

b. Because of the number of airports contacted, and after an analysis of the data, it was indicated that the 519 evacuation events identified by the research effort represented only 90% of the actual events that were thought to have taken place. Therefore, the number of events that had taken place was estimated at 576. Unless noted elsewhere, 576 was the number used to calculate monthly and yearly averages.

c. The FAA had reports on 224 or 43.2% of the actual events and the NTSB had data on less than 10% of the events. In many cases, the FAA and NTSB data did not contain information on the same event.

d. Data was received from 136 airports which represented 90% of passenger enplanements (1995 data) and an estimated 90% of the known evacuation events. The response rate from airports was 92.1%. In cases where airport management did not furnish data, local or airport CFR records had the required information.. Twelve airports accounted for 50% of the evacuations and 12 additional airports (24 airports total) accounted for 70% of the evacuations.

e. The 576 evacuation events would have resulted in some 47,520 airline passengers and crew members being forced to evacuate an aircraft under non-crash (accident) circumstances. It

has been estimated that as many as 75% of all precautionary evacuations were not necessary and could have been avoided.[6]

f. A subset of three years, 1991, 1992, and 1993, were selected for further study. During this period 193 evacuations were reported. The norm for a three year period was 194, therefore the sample size was within 99.5% of the norm. Data on reported passenger injuries from evacuations during the same time period from eight major airlines was reviewed. There were 250 reported emergency evacuation related injuries by these airlines. The industry total was estimated to have been 462, so the sample size was 54.1% of the norm. Of the 250 reported injuries:

sex: male 71 (44.4%)	female 89 (55.6%)	when reported (n = 160)
age: male 41	female 48	when reported (n = 84)

(29.8% of all passengers who claimed injuries were over age 60)

g. In cooperation with the management of these airlines, a more detailed review of 185 injury claims was made (this was 74% of the 250 reported injuries). Timely and useful data was available on 31 of the claims. Two claims, one for 5.0 and one for 10.0 million dollars (both for emotional and/or not confirmable injuries) were eliminated from the sample when compiling the following statistical data which is based upon an average of 154 industry wide claims per year:

45 (29.0%) would be minor ($9,999 or less)	average claim $ 5,459
65 (41.9%) would be substantial ($10,000 to $49,999)	average claim $ 17,380
44 (29.1%) would be serious ($50,000 or higher)	average claim $ 260,235

h. The administrative costs of processing and resolving these claims was estimated to be:

minor claims $ 1,000; substantial claims $ 2,500, serious claims $25,000, trials $75,000

i. The annual total cost of processing and resolving injury claims was estimated to be $14,983,195. About 38.8% of the claims had to litigated, with 9% progressing to the trial stage. However, only about 1% of the claims actually completed the trial process. The average of all reported claims that were litigated at trial cost $551,507.00 each. This is slightly less than what Federal agencies were recommending, which was that "a serious aviation injury should be valued at $640,000.00.[7]

j. In addition to payments to injured passengers and administrative costs of processing these claims, there are other costs. Maintenance costs and lost aircraft revenue associated with the use of an aircraft's emergency egress system must be considered. Taking into account the types of aircraft that had emergency egress systems deployed, and the number of events, the estimated annual cost of precautionary evacuations was $1,005,283. There is additional cost of

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[6] Hynes, M. (1997). "Management's Role in Air Carrier *Non-crash Related* Emergency Evacuation Events and Preventing Injuries for Them," Jerome Lederer Colloquium, College of Aeronautics, NY, NY.

[7] APO Bulletin 90-1, "Treatment of the Value of Life and Injury in Economic Analysis", October, 1997, GPO, Washington, DC.

the utilization of airport staff and equipment while the emergency evacuation was taking place. While these costs can be considerable, no effort was made to tabulate them.

k. Based upon the costs identified in the preceding paragraphs g., h., i. and j., the total annual costs of precautionary emergency events, to airlines and consumers, was estimated to be in excess of $15,988,478. The "average" evacuation may cost as much as $245,977 (based upon 65 evacuation events per year).

l. The type of aircraft on which the emergency evacuation took place was normally identified. However, since no data on the size of the airline industry's fleet re. any one make or model of aircraft, nor the frequency of flights by any one type of aircraft was available, no significant conclusions could be made as to the effect aircraft types had on the potential for passenger injuries. However, it was obvious that in 100% of the cases, when a "wide body" aircraft had an evacuation event, there were injuries reported. Also, almost every time an emergency egress system was deployed, injuries were reported.

Findings from the FAA/CAMI Contract No. 97-P-53815

a. The period studied was from February 1, 1994 through November 30, 1996, a 34 month period. At the time of the research (late 1997), it was felt that records on evacuation events before February 1994 were either already destroyed or placed in long term storage. This would make them impossible or difficult to review. It was also felt that events that had taken place after November 1996 were still "current" events that might be subject to litigation claims from injured passengers. Because of the potential for litigation, airports (and their staff) were usually not willing to share information on these events.

b. By reviewing the 1996 FAA/CAMI contract data, it was determined that by selecting only 24 airports, data on 70% of all reported emergency evacuation events could be obtained. These airports also accounted for 47.3% of passenger enplanements (based on 1995 data). The response rate from the 24 airports was 100%.

c. At the 24 airports selected, 109 emergency evacuation events took place during the 34 month period. In 19 of these events, 193 persons reported injuries. The available demographic data on the persons who reported injuries was:

sex: male 71 (41%)	female 102 (55%)	unreported 20
age: male 41.7 (n=32)	female 45.1 (n=60)	unreported 1
ages ranged from 3 to 82	ages ranged from 2 to 80	

d. The data showed that 16.8% of the passengers who claimed injuries were over age 60. However, airport and medical staff often did not record age information. When questioned about this, they stated that elderly persons, especially women, did not wish to state their age. For this reason, the average age of airline passengers, including those who were injured in evacuation events, was most likely much higher than what was shown in the results of both the 1996 and 1997 FAA/CAMI research contracts.

e. Of the 193 persons who reported injuries, 26 (13.5%) refused medical assistance at the time of the event and 167 (86.5%) obtained medical care. Some 113 (67.6%) of the reportedly injured persons were transported to a non-airport medical facility.

f. Of the 167 persons who required medical assistance, medical data on 135 persons (81%) was available. This data indicated the following types of reported injuries:

back/neck	53	34.2%	abrasions	12	7.7%
leg/foot	27	17.4%	abdominal/chest pains	10	6.5%
cuts	15	9.7%	sprains	8	5.2%
broken bones	11	7.1%	minor	19	12.3%

(totals exceed 135 because of specific reporting of multiple injuries)

g. Data was sought on the weight and height of the injured passengers who received medical treatment. This information was not available in most cases. When questioned about this, airport staff indicated that weight information was seldom given by the injured passengers, and even when given, it was usually not correct. Height data was not asked for on most airport injury reports or the information was missing on almost every report that was reviewed for the research. Airport staff seemed to feel that this information was not important and therefore they made no effort to acquire this type of information.

h. As was the case in the 1996 FAA/CAMI research report, the type of aircraft on which the emergency evacuation took place was normally identified. However, since no data on the size of the airline industry's fleet re. any one make or model of aircraft, nor the frequency of flights by any one type of aircraft, was available, no significant conclusions could be made as to the effect aircraft types had on the potential for passenger injuries. However, it was obvious that in 100% of the cases, when a "wide body" aircraft had an evacuation event, there were injuries reported. Also, almost every time an emergency egress system was deployed, injuries were reported.

RECOMMENDATIONS

The following recommendations were suggested by the results of the past six years of research projects conducted by Hynes on the subject of emergency evacuations. Most of these recommendations were listed in the reports given as part of the 1996 and 1997 FAA/CAMI Contracts.

a. Because information on the use of aircraft emergency egress systems, and undertaking precautionary emergency evacuations, has a high value in the aircraft and airline certification process, as well in developing programs for the training of airline flight and cabin crews, research on this subject should be continued.

b. In view of the large number of airline passenger and crew members who are forced to undertake an emergency evacuation each year, there is a strong potential for higher social and economic losses in the future from injuries that may occur during these events. Efforts to better understand the dynamics of emergency evacuation events, and especially by reducing the number

of precautionary evacuations, will result in substantial economic savings to airlines and consumers. These savings should justify funding for additional research on the subject of emergency evacuations.

c. The quantity and quality of the reporting on the use of emergency egress systems, and precautionary evacuations where egress systems are not used, needs to be addressed. Changes in regulatory wording, FAA Inspector Handbooks, and airline policies in this area need to be studied further. With minor changes, the regulations and systems already in place may yield the information needed to properly evaluate the effectiveness of the FAA's and NTSB's oversight of this important area of air carrier safety. Standardized, multi part forms and the publication of an FAA Advisory Circular on the subject of the use and reporting of emergency egress system use and the conducting of precautionary evacuations should be undertaken. Once reported to either the FAA or NTSB, data on evacuation events must be "pooled" between the agencies and uniform key word coding utilized so that the data can be retrieved in an efficient manner. Only after accomplishing this, will the data contain reliable safety information.

d. Airline policies and FAA guidelines should be reviewed as to the "Aeronautical Decision Making" (ADM) steps flight and cabin crews should take before undertaking precautionary evacuations. A simple word change on an airline's flight crew Emergency Checklist might result in a significant reduction in these events. An example of such a wording change is being considered by one major airline. The change being considered is to add to the checklist:

PASSENGER EVACUATION

NO DOUBT, GET OUT
EVALUATE BEFORE YOU EVACUATE
CREW COMMUNICATION

Good cockpit resource management (CRM) may call for the question...
Captain is this evacuation really necessary?

e. Additional attention needs to be given by airline management to company policies re. what conditions should exist before precautionary evacuations are to be conducted vs. the almost rote carrying out of evacuations under questionable circumstances. The subject of precautionary evacuations is not emphasized during CRM training, and very little joint flight and cabin crew training on evacuations is conducted.

f. There is a need for a common radio frequency to be used during conditions where an evacuation might take place. The emergency frequency of 121.5 should be considered for this purpose. A breakdown in radio communication is a common factor leading to passenger injuries.

g. Factors that might reduce the potential for passenger initiated evacuations should be reviewed. Torching and smoking when starting aircraft engines or auxiliary power units (APU) has been the most common cause of passenger initiated evacuations. Minor maintenance changes to APU fuel controllers has resolved this problem for one airline. The addition of wording on Passenger Safety Briefing Cards re. the starting of these engines, and visible vapors from overhead vents due to moisture, might also reduce the potential for passenger initiated evacuations. Cabin crew should strongly advise passengers "*Do not attempt to evacuate an aircraft unless told to do so by a crewmember*."

h. Existing FAA regulations on male/female ratios required during evacuation simulations for aircraft and airline certification needs to be reviewed. The present required ratio is 30% female. The ratio of female airline passengers seems to be increasing with time. As shown by this research, the ratio may be approaching 50%. The same concern applies to the present number of persons over the age of 60. Current regulations require that only 5% of passengers during simulated evacuation be over the age of 60. It is a well known fact that the over age 60 portion of the American population is growing very rapidly. This is being reflected in the higher number of elderly passengers now traveling on air carriers. The research showed that the ratio of elderly passengers may be approaching 30%.

i. While no effort was made to analyze the potential for passenger injuries by make and model of aircraft, it was indicated by the research that in almost 100% of the cases, wide body aircraft had passenger injuries during evacuations. Some additional research on this finding should be undertaken.

j. Based upon statements made by passengers and cabin crew members, airline procedure manuals should be reviewed as to the subject of carrying out emergency evacuations. In many cases, there was expressed a need for more than one "able bodied assistant" at the aircraft exits and on the ground at the base of the deployed egress system.

k. Seeking information on injured passenger weights and heights may not be productive. While this information may be of interest to some researchers, when considering the attitude of passengers when responding to questions on this subject, and the attitude of medical personnel re. the need for this data, it would seem that what data is recorded may not be accurate from a statistical viewpoint.

l. A review of airport and air carrier policies on when and where precautionary emergency evacuations are conducted should be made. In many cases, the need for the evacuation could have been resolved before the evacuation took place. At other times, the availability of ground equipment (portable stairs) would have removed the need for the use of an aircraft's emergency egress system. On a few occasions, passenger injuries post evacuation could have been prevented if the evacuation had taken place in a safer location on the airport.

Copies of past studies are available upon request to the author.

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APPENDIX A - ANALYSIS GUIDELINES for the 1997 STUDY DATA

1. DATE: When conflicting dates were indicated by the input data, the date shown in the study is the most likely date the event actually happened. Information received directly from airports was considered the most accurate.

2. WHERE: Airport names and ID codes (the top 50 US airports and 86 other airport locations, 136 facilities total) that were known to have had an EMERGENCY EVACUATION EVENT were used for the study. (Refer to Appendix A.)

3. TYPE A/C: Aircraft types, B727, B747, DC10, etc.

4. AIR CARRIER: Aircraft operator, ID codes and type of operation (MAJOR Part 121 or COMMUTER Part 135). Small aircraft (Cessna, Beech 18, Piper etc.) operated under Part 135 were not included.

5. FAR PART: 14 CFR Federal Aviation Regulation Part 121 or Part 135.

6. # CREW & PAX: Crew member and passenger counts combined when known. If this data was missing, statistical data, based on aircraft type was used and the data is marked with an "E".

7. # INJURIES: Number of injuries reported by any data source and was supplemented by data from airlines and litigation research. If this data was missing, statistical data, based on aircraft type was used and the data is marked with an "E".

8. #S INJURIES: Number of serious injuries reported by any data source (required hospitalization, broken bones, etc.) and was supplemented by data from airlines, insurance firms, and litigation research. If this data was missing, statistical data, based on aircraft type was used and the data is marked with an "E".

9. SLIDES USED: Yes (Y); No (N); No data (?); No slides installed on aircraft (N/A).

10. REASON AND REMARKS: Reason for the evacuation and details of the event when known.

11. DATA SOURCES: All data sources that reported the event, such as FAA, NTSB, etc. Refer to DATA SOURCE CODES shown on each page of the report.)

DATA REQUESTED FROM AIRPORTS

Ref: FAA Contract No. 97P53815 **EMERGENCY EVACUATION STUDY**

AIRPORT: (name filled in prior to mailing) Reported by: (staple your business card or give us your)

NAME:

EVENT # DATE TYPE AIRCRAFT CARRIER # of reported injuries Title:

(this data was finned in prior to mailing) Phone:

Were slides used? Yes No Remarks:

Address:

City-

State-Zip:

Are copies of Incident Response records or other type of reports available for public inspection? YES NO

Please provide the requested data on the above event ***using any available source*** of information.

Person #	Crew or Pax?	age	sex	weight	height	Injury type, severity and cause (Broken bones, burns etc. - TRIP/FALL, SLIDES etc.)	Hospitalized? Yes/No Where
1							
2							
3							
4							
5							
6							
7							
8							
9							
						Is there a second page? YES NO	

Note: If more persons were injured, please copy this form.

EES9702

TELEPHONE INTERVIEW FORMAT

Hello *My name is* _____ and I am calling you from Oklahoma.

I work with Hynes and Associates, Inc. an Oklahoma aviation research company.

We are working on a contract for the Federal Aviation Administration, the FAA.

You were listed as one of the people who were on a ____ Airlines flight back in 19 ,

that had a problem at the _____ airport.

1. Am I speaking to the right person?	YES NO

(If yes, continue...if no---attempt to locate the correct person and continue.)

I have been asked to contact you to see how you are doing and to talk to you about the event and any injuries you may have incurred.

If you don't have a few minutes to talk to me now, when would it be a good time for me to call you again?

2. Do you remember the event?	YES NO
3. a. Do you remember what your injuries were? b. Can you tell me what your injuries were?	YES NO

4. a. Do you remember what caused your injuries? b. Can you tell me what caused your injuries or how you were injured?	YES NO
5. Did you have to go to a hospital?	YES NO How long?
6.a. Were you disabled as a result of your injuries? b. Did you stay home from work? c. How long were you disabled?	YES NO YES NO DAYS WEEKS MONTHS
7.a. How are you feeling now?	
8.a. Did you receive any financial help from the airline? b. Do you feel that it was fair? c. Did you need to use an Attorney? d. What type (amount) of help did you receive?	YES NO YES NO YES NO
9. We show that you were years old back then?	Is that correct? YES NO(Correct age was)
10. About how tall are you?	ft inches
11. Do you remember what your weight was back then?	lb.

Remarks:

Note: Because of the time delay between the evacuation event and the attempt to conduct a telephone interview, a large number of reported phone numbers were no longer valid.

EEE9801

APPENDIX C *Part 121 and 135 Air Carrier Emergency Evacuation Study*

DATE	AIRPORT LOCATION	TYPE A/C	AIR CARRIER & FAR PART	# CREW & PAX	# INJ S INJ	SLIDES	REASON and REMARKS	DATA SOURCE
08/29/92	ORD	S360	? 135	25	0	0	N/A	HYD FAILURE D
08/29/92	ORD	AT42	? 135	24	0	0	N/A	PAX DEPLANED & BUSSED TO TERMINAL D
08/30/92	BOS	DC9	PJX 121	161	0	0	?	TIRE FAILURE ON TAKE OFF ROLL AI,DN,FI
09/14/92	ORH	DC9	AAA 121	72	0	0	?	BLEW MAIN TIRES, ABORTED TAKE OFF DN,FI
09/27/92	EFD	AT42	BRT 121	29	0	0	N/A	OIL PRESS LIGHT DNC_1F1
10/01/92	ATL	MLG	? 121	50E	2E	lE	?	ELEC FAIL, BLOWN TIRES A1,DN
10/12/92	PIT	B737	AAA 121	136	0	0	?	ENG FAIL NR2, ABORTED TAKE OFF A1,DN,F1,F2,M1
10/17/92	RIC	B737	AAA 121	24	0	0	NO	SMOKE ENG START, EXIT DOOR USED D
11/02/92	ORD	B747	? 121	272	0	0	?	BLOWN TIRES D
11/08/92	JFK	B767	UAL 121	58	0	1	NO	SUSPCT BOMB, STAIRS USED D
11/18/92	DTW	S227	MSA 135	9E	0	0	N/A	SMOKE IN CABIN,EVAC DN,F4
11/27/92	ORO	B737	DAL 121	123	11	2	NO	APU SMOKE, PAX START DN,F2,N3,L2
12/30/92	ORD	AT42	? 135	24	0	0	N/A	SMOKE IN #1 ENGINE D

01/01/93	OKC	B737	CAL	121		108	0	0	NO	SLID OFF TWY, PORT AIR STAIRS USED D
01/02/93	DEN	DC9	MDX	121		47	0	0	?	OVERAN RWY, LOST PART OF ENG D
01/10/93	DFW	DC9	AAL	121		89	5	1E	YES	SMOKE LFT MAIN GR, NO FIRE A2,DN,F2,F3,L2,M1,N3
01/10/93	DEN	MD80	CAL	121		106	4	1E	YES	HARD LANDING DN,F2
01/11/93	RIW	1900	BRT	121		14E	0	0	N/A	WHITEOUT, OFF RWY HIT DITCH DNC,F3
01/15/93	BFL	B737	DAL	121		114	2	1E	?	SMOKE IN COCKPIT, NO FIRE DNC,F1,F2,F3$_1$L2
01/20/93	USM	B727	AAL	121		99E	0	0	?	MISALIGN WITH RWY, LOW RVR D
02/01/93	IAN	B727	UTA	121		19	0	0	YES	APU FIRE, SMOKE/NO FIRE DN,F1,F2,F3
02/10/93	PBI	B737	UAL	121		103	0	0	?	JET FUEL LEAK D
02/11/93	DSM	DC9	TWA	121		67E	0	0	?	WENT OFF TWY, LOW RVR D
02/19/93	DEN	B757	DAL	121		141	0	0	?	BOMB THREAT D
02/19/93	SJC	B737	DAL	121		61	0	0	?	BLOWN TIRE D,F3
02/22/93	BOS	S340	BEX	121		24E	4	lE	?	LANDED WITH NOSE GEAR RETRACTED DN,F3
02/24/93	ORD	B737	UAL	121		82E	1	0	YES	HOT START, PAX START A1,DN,F2,F3$_1$L2
02/24/93	FLL	B757	DAL	121		183	0	0	NO	BLEW 4 MAIN TIRES, NOSE GEAR DAMAGE D3
03/01/93	CLT	S360	AAX	121		36	0	0	NO	SMOKE IN COCKPIT D3
03/13/93	CLT	B737	AAA	121		131	0	0	NO	SKIDDED OFF TWY D3
03/13/93	ORD	FI00	AAA	121		104	0	0	N/A	NOSE GEAR FA1LURE D,F3
03/25/93	BNA	B737	SWA	121		125	0	0	YES	BOMB THREAT D,F2
03/29/93	SF0	A310	DAL	121		127	36	16E	YES	SMOKE IN CABIN, NO FIRE A1$_1$D,F2,F3$_1$L2

DATASOURCECODES

A = ARSA (NASA) Reports
- Al = 11/19/93 Report No. 3223
- A2 = 04/01/96 Report No. 4412
- A3 = 12/12/96 Report No. 4704

D = Direct contacts with airports
- D = 1993, 1994, and 1995 contacts
- D3 = 1996 contacts
- DN = Event not reported by airport
- DNC = No contact with airport
- DNR = No response from airport

F = FAA Data
- Fl = 03/24/93 Report No. P3-03-0206
- F2 = 03/10/95 Misc. data at FAA/CAMI
- F3 = 04/04/96 Report No. PT6-03-053
- F4 = 01/28/97 Report No. AFS624/HH

L = Litigation Data
- L1 = WESTLAW
- L2 = Airline data

M = Media data
- M = Newspapers
- M1 = Aviation Safety Week

N = NTSB Reports
- N1 = 06/24/92 Report
- N2 = 05/11/93 Report
- N3 = 12/24/96 Report

(One page sample of pages 4 through 18, FAA/CAMI Contract No. 96-P-51602, March, 1997)

APPENDIX D - SPECIFIC DATA ON EVACUATION INJURIES

Ref #	SEX	Age	Wgt	A/C	Injuries	Injury description and cause	Hosp	Slides
151	F			MD80	Yes	Not reported	Yes	?
152	M			MD80	Yes	Head & neck injury	?	?
153	M			MD80	?	Not reported	?	?
154	F			MD80	?	Not reported	?	?
155	F			MD80	Yes	Muscle pain left leg	?	?
156	F			MD80	Yes	Bruises	?	?
157	F			MD80	Yes	Chest pain	?	?
158	F			MD80	Yes	Bruises	?	?
159	M			MD80	Yes	Lower back pain	?	?
160	F			MD80	?	Not reported	?	?
161	M	27		MD80	Yes	Head & knee pain	No	?
162	F	29		MD80	Yes	Neck, knee & back	No	?
163	M	34		MD80	Yes	Bruised/cut right knee	No	?
164	M			MD80	Yes	Lower back, broken vertebrae	Yes	?
165	M			MD80	Yes	Lower back pain , right thumb cut	Yes	?
166	M			MD80	Yes	Neck & head injuries	Yes	?
167	M			MD80	Yes	Not reported	Yes	?
168	M			MD80	Yes	Shoulder & rib injury	Yes	?
169	M			MD80	Yes	Neck injury/whiplash	Yes	?
170	F			MD80	Yes	Back pain	Yes	?
171	M			MD80	?	Not reported	?	?
172	M			MD80	Yes	Back pain	?	?
173	M			MD80	Yes	Head & neck injury	?	?
174	M			DC9	?	Minor lower back injury-RMA	No	Yes
175	M	73		DC9	Yes	Injury to neck, back, shoulder	?	Yes
176	F	55		DC9	Yes	Possible injury to left ankle	Yes	Yes
177	M	34		DC9	?	Abrasion to left elbow-RMA	No	Yes
178	F	54		DC9	?	Abrasion to right elbow-RMA	No	Yes
179	M	82		DC9	Yes	Bump on head/lower back pain	Yes	Yes
180	F	48		DC9	Yes	Lower back-Fell off wing	Yes	Yes
181	F	52		MD80	?	RMA	No	?
182	F	76		MD80	?	High blood pressure-RMA	No	?
183	F	49		MD80	Yes	Injuries to neck, head, back	Yes	?
184	F			DC9	Yes	2nd degree burns-puncture wound	Yes	Yes
185				DC9	Yes	Ankle injury	No	Yes
186	M			DC9	Yes	Back injury	No	Yes
187	F			DC9	Yes	Smoke inhalation	No	Yes
188				DC9	Yes	Laceration	No	Yes
189				DC9	Yes	Contusions	No	Yes
190				DC9	Yes	Lacerations, smoke inhalation	No	Yes
191				DC9	Yes	Lacerations, smoke inhalation	No	Yes
192				DC9	Yes	Lacerations, smoke inhalation	No	Yes
193	F			DC9	Yes	Lacerations, smoke inhalation	No	Yes

RMA = Refused Medical Assistance.

The 193 persons listed above incurred injuries during 19 precautionary emergency evacuations. In two of the evacuation events, the aircraft were not equipped with an emergency egress system (slides) but passengers were injured.

(One sample page of 4 pages, FAA/CAMI Contract No. 97-P-53815)